design ideas

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Oscillator meets three requirements

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THREE COMMON REQUIREMENTS for a clock source are a wide frequency range, a variable duty cycle with independently adjustable T_{ON} and T_{OFF} times, and the ability to synchronize with an external signal. The gated oscillator in **Figure 1** satisfies all three requirements using just one 74LS123 and a handful of passive components.

To analyze the circuit, first assume that the A input of one-shot IC_{1A} connects to ground. Then, IC_{1B}'s positive-going $\overline{Q}$ output triggers the B input of IC_{1A}, whose negative-going Q output triggers the A input of IC_{1B}. This dc positive feedback ensures that the circuit always self-starts.

The time constant $C_2\times(R_2+R_4)$ determines the width of T_{ON}, and $C_1\times(R_1+R_3)$ determines the width of T_{OFF}. For the 74LS123, the values of the external components at R_{EXT} and C_{EXT} essentially define the output pulse width, t_W, according to

$$t_W = K \bullet R_{EXT} \bullet C_{EXT},$$

where k=0.45 for C_{EXT}>1000 pF. Assuming that $R_A=R_1+R_3$ and $R_B=R_2+R_4$, the period and the duty cycle are as follows, respectively:

$$T = K \bullet R_A \bullet C_1 + K \bullet R_B \bullet C_2;$$

$$\text{DUTY CYCLE} = \frac{t_{ON}}{t_{ON}+t_{OFF}} = \frac{K \bullet R_B \bullet C_2}{K \bullet R_A \bullet C_1 + K \bullet R_B \bullet C_2} = \frac{R_B \bullet C_2}{R_A \bullet C_1 + R_B \bullet C_2}.$$

If $C_1=C_2$, then

$$\text{DUTY CYCLE} = \frac{R_B}{R_A+R_B}.$$

The circuit oscillates at the frequency

$$f = \frac{1}{t_{ON}+t_{OFF}} = \frac{1}{K \bullet R_A \bullet C_1 + K \bullet R_B \bullet C_2}.$$

Over the 74LS123's operating range,

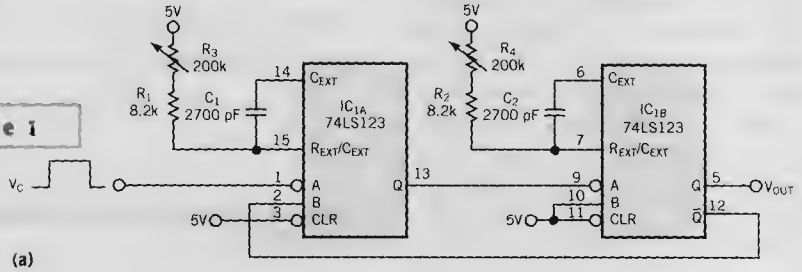
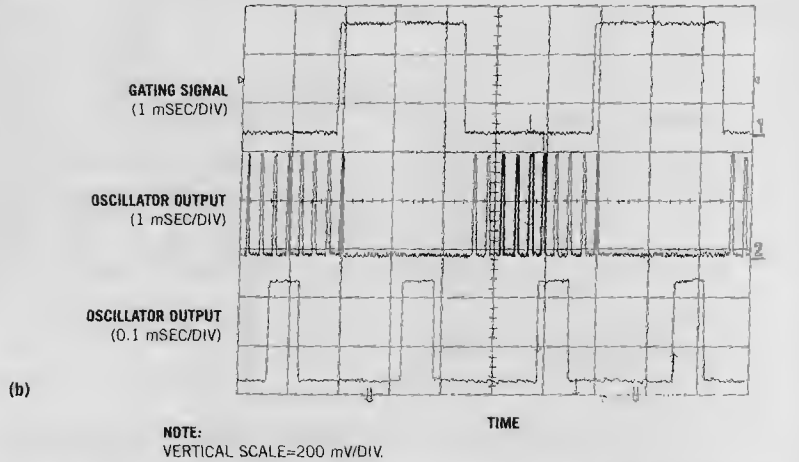


Figure 1



A gated, astable oscillator (a) has an independently variable T_{ON} and T_{OFF}. The oscillator output is on when the gating signal is low (b).

which is 5 kΩ≤R_{EXT}≤200 kΩ and assuming no limits for C_{EXT}, the duty cycle is 100% when R_A=5 kΩ and R_B=200 kΩ. The duty cycle is 0 when R_A=200 kΩ and R_B=5 kΩ. And, because T_{ON} and T_{OFF} are independent, you can vary the frequency without affecting the duty cycle.

You can easily turn the circuit into a gated oscillator by applying a square-wave gating signal (V_C) whose frequency is less than the oscillation frequency (f) to the A input of IC_{1A}. The oscillator output is low when V_C is high and is free-running when the gating signal is low. In **Figure 1b**, the gating signal is 200 Hz, R_A=170 kΩ, R_B=50 kΩ, and C_{EXT}=2700 pF. With these values, T_{ON}≈60 msec, T_{OFF}≈206 msec, and f≈3741 Hz. (DI #2276).

Simple circuit provides digital hysteresis

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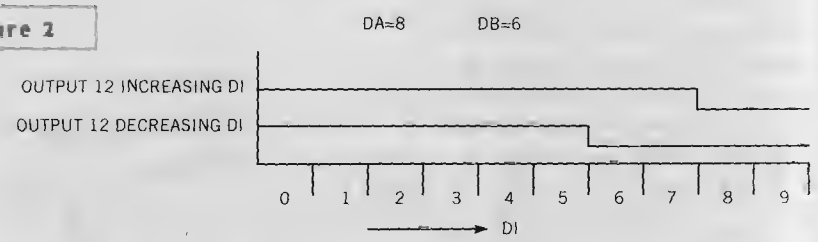
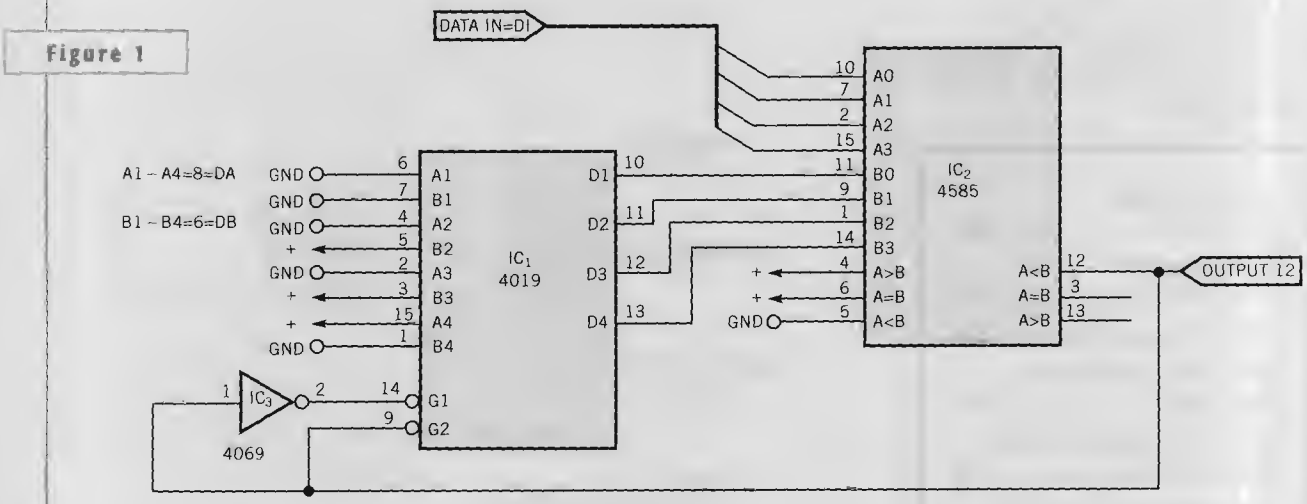
It is sometimes useful to have hysteresis in a digital circuit—for example, in a power circuit under the control of a manual pulse generator, in which mechanical vibrations can produce position errors. The circuit in **Figure 1**, which consists of a 4585 comparator (IC_2), a 4019 switch (IC_1), and one-sixth of a 4069 inverter (IC_3), provides digital hysteresis. If DI=0, DA=8, and DB=6, then Output 12 and G2 of IC_2 assume logic 1, and G1 of IC_2 assumes logic 0. Switch IC_1 thus connects DA (8) to comparator IC_2. When DI=8, Output 12 assumes logic 0 and switch IC_1 connects DB (6) to the comparator. If DI is greater than 8, then Output 12 remains at logic 0. If DI becomes less than DB, then Output 12 assumes logic 1. **Figure 2** shows a pulse diagram. You can expand the circuit by adding more comparators and switches. (DI #2274).

Figure 2



The hysteresis in Figure 1's circuit is the difference between the switching points for increasing and decreasing DI signals.

Figure 1



Digital hysteresis can provide a "debounce" function in digitally controlled switching circuits.